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The Function of the Oblique Muscles in Certain Cases of Astigmatism.

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THE FUNCTION OF THE OBLIQUE MUSCLES IN CERTAIN CASES OF ASTIGMATISM.

So much has been said and written about astigmatism that it would seem that nothing more of a practical nature could be added.

Before proceeding to the study of the function of the oblique muscles in certain forms of astigmatism, I would briefly review what has long been known. The rule, with many exceptions, is that astigmatism is due to the radius of curvature of the vertical meridian of the cornea being shorter than the radius of curvature of the horizontal meridian. The exceptions are that the meridian of greatest curvature may be horizontal or may be at any degree between the vertical and the horizontal. The meridian of least curvature is always at right angles to the meridian of greatest curvature. In hypermetropic astigmatism, whether simple or compound, the best meridian is usually vertical or within 45° of the vertical; in myopic astigmatism, as a rule, the best meridian is horizontal or within 45° of the horizontal. In the one instance horizontal lines or those nearly horizontal are best seen, while in the other, vertical or nearly vertical lines are most distinct. It is well known that, other things being equal, astigmatism is least troublesome to a patient if the best meridian is vertical, as in hypermetropic astigmatism, or horizontal, as in myopic astigmatism. In all other cases the nearer the best meridian is to the vertical or to the horizontal, the more favorable it is to the patient's comfort.

More than two years ago my observation of hypermetropic astigmatics led me to the conclusion that there is less discomfort to patients, if the best meridian of one eye is on one side of the vertical, *e. g.*, at 100°, and the best meridian of the opposite eye is on the other side of the vertical, *e. g.*, at 80°, than if both were on the same side of the vertical. A similar study of myopic astigmatism respecting the relative positions of the best meridians and the horizontal, led me to a like conclusion. I was not long in surmising that the oblique muscles must have something to do in cases of astigmatism where the best meridian is neither at 90° nor 180°. What this function is I now no longer surmise, having observed it often. It is to so rotate the eye on its antero-posterior diameter as to bring its best meridian to the vertical or to the horizontal. The oblique muscles, at best weak, soon become fatigued, and if not allowed to rest must become the source of great discomfort. For some time I was in doubt as to how they acted. It is now clear that the superior oblique of one eye must act with the inferior oblique of the other, the one muscle under the control of the fourth nerve, the other under the control of a branch of the third nerve, otherwise double vision would result, as I am able to show by means of these diagrams. The rotation of one eye towards, and of the other from, the median line, keeps corresponding parts of the retinæ in the same relative position, hence the images of external objects fall on parts of the two retinæ that act together.

Let us study why it is that the condition is more favorable if the best meridian of one eye is at 100°, and the best in the other at 80°, than if these meridians were, in both eyes, at 100° or 80°. If the best meridian of right eye be at 100° and that of left eye at 80°, the right superior oblique will roll the globe 10°, thus bringing the best meridian to the vertical, the most favorable position; the left inferior oblique will roll its eye out 10°, thus placing its best meridian at an angle of 70°, not so favorable to sharp sight as its natural position. The better image in the right eye is the one the brain takes cognizance of for the time. Soon the labor is shifted, in time too short to be computed, from the right superior and left inferior oblique to the left superior and right inferior oblique muscles, when the best meridian of the left eye is brought to the vertical, and the best meridian of right eye is turned to an angle of 110°. Now the sharper image is on left retina, and is the one the brain takes cognizance of until the labor is again shifted. This state of activity on the part of the oblique muscles alternates with the state of rest; and, consequently, the fatigue is less than if a state of tonic contraction had been kept up.

If the best meridian of the two eyes be at 100°, the superior oblique of the right eye and the inferior oblique of the left eye will roll their respective eyes so that, at the same moment, the best meridian of each eye is vertical. Other things being equal, an equally sharp image is formed in the two eyes. A state of tonic contraction on the part of these muscles is necessary so long as anything approaching accurate vision is maintained. This is necessarily attended by much fatigue and in many cases by suffering.

If the best meridians are near the horizontal in the two eyes, the one at 170° in the right and the other at 10° in the left eye, then the oblique muscles will so act as to place first the best meridian of one eye and then the best meridian of the other horizontally, etc., as I have shown in the conditions where the object of the rotation was to get the best meridians in the vertical position.

This habit of rotation is formed in early life, and, unless the condition on which it depends is corrected, is continued throughout life; the symptoms caused by this rotation have, therefore, a duration commensurate with one's existence. Not so with those symptoms caused by what is ordinarily known as eye-strain, for at the age of 60 years, a little earlier or a little later, the ciliary muscle has lost all its power, therefore the symptoms due to the exercise of this power have vanished; the loss of this ciliary power being gradual, the symptoms disappear by occurring at longer intervals and being less severe.

As I have demonstrated to you, the action of the oblique muscles in giving to certain astigmatics a condition of things favorable to sharper sight, is harmonious but not symmetrical, the superior oblique of one eye acting with the inferior oblique of the other, just as the internal rectus of one eye may act harmoniously with the external rectus of the other, *e. g.*, with my face fronting the end of this room, if I look to the right the external rectus of my right eye acts with the internal rectus of my left eye in directing the visual axes toward the object at which I may be looking. The action is harmonious but not symmetrical.

If I fix my vision on this page before me my visual axes are directed towards it by the symmetrical and harmonious action of the two internal recti muscles. In like manner the action of the oblique muscles is, under certain conditions, symmetrical and harmonious, as was long ago pointed out by physiologists. The superior and inferior recti approach the eyeball obliquely and are so attached. When they contract they not only cause the eye to revolve on its horizontal diameter, but they also cause a slight revolution to take place on the antero-posterior axis. If the vision be directed upwards the superior recti, acting harmoniously as they always do, not only make the visual axes point up but, on account of the obliquity of their attachments, they would rotate, if unopposed, the two eyes on their antero-posterior axes so as to make the upper end of the vertical meridian of each eye turn towards the nose, and thus would produce double vision. This action is opposed by the two inferior oblique muscles, which are thrown into a state of harmonious and symmetrical contraction, each keeping the vertical meridian of its own eye in its normal position, thus preventing double vision. I may say here that the branches of the third nerve supplying the superior rectus and the inferior oblique muscles deserve, if any nerve does, the name "patheticus," which in no sense belongs to the fourth nerve.

When the gaze is directed downwards the inferior recti would not only turn the eyes in that direction but, if unopposed, would also so rotate the eyes on their antero-posterior axes as to turn the lower end of their vertical meridians towards the nose. In this condition the superior oblique are the muscles that oppose and by their opposition keep the vertical meridians parallel. In speaking above of the harmonious and symmetrical action of the oblique muscles I have had in mind an emmetropic eye. Physiology very properly lays stress on this kind of action on the part of these muscles and, with a single exception, it is the only function ascribed to them by physiologists. The exception is this: If the head be turned to one side, the eyes being emmetropic, the oblique muscles will act harmoniously but not symmetrically in so revolving the eyes as to compel the vertical meridian still to remain vertical notwithstanding the inclination of the head; *e.g.*, supposing my own eyes to be emmetropic this teaching would lead me to believe that, if I were to incline my head 15° towards the right, the right superior oblique and left inferior oblique muscles would each so act on its own eye as to revolve it through an arc of 15° to bring the naturally vertical meridians back to the vertical position, a thing not necessary, nor do I believe it ever occurs. I am certain it does not occur in astigmatic eyes made emmetropic by means of a proper cylinder. Suppose, as is nearly true in my own case, that a man has simple hypermetropic astigmatism, the perfect meridian being at 90°. He has been given the proper convex cylinder with its axis, of course, at 90°. To all intents and purposes his eyes are now emmetropic. Let him incline his head 15°. Should his oblique muscles now rotate his eyes 15° his vision would be made worse, in the same manner as revolving his glasses through an arc of 15°. Since this does not occur, as I personally know, for I can see as sharply with my head inclined as when it is erect, I conclude that harmonious non-symmetrical action of the oblique muscles has no existence in emmetropic eyes, whether naturally so or made so by means of proper correcting glasses.

I feel that I can say without fear of successful contradiction that the real and only harmonious, non-symmetrical action of the oblique muscles of the eye is that, already pointed out by me in this paper, for rendering sharper the acuteness of vision in certain forms of astigmatism.

The most beautiful part of this theory is that it has a practical side. For two years it has been of incalculable benefit to me, enabling me, in many instances, to do successfully work that had been a failure in the hands of others. One remarkable case is, at this moment, in my mind. About 10 years ago a lady, then about 25 years old, consulted a reputable ophthalmic surgeon for symptoms which she had been led to attribute to her eyes. He found one eye useless from an old central choroiditis; but the fundus of the other eye was perfectly healthy. The good eye, however, had compound hypermetropic astigmatism with the best meridian of the cornea, as he determined it, at 180°. He justly attributed her symptoms to this defect and prescribed a sphero-cylindrical lens for its correction, placing the axis of the cylinder at 180°. For months this lady persevered in the use of her spectacles, obtaining no relief. At last, in despair, she laid them aside. About 8 years later she was encouraged by some of her friends, for whom I had done some refracting work, to consult me. I examined the glass given her by the surgeon referred to above, determined its strength and the location of the axis of the cylindrical part. Under homatropia I made a most careful examination. After the exercise of much patience and perseverance, I determined that the best meridian was at an angle of 165° and not at 180°. I prescribed for her, as I now remember, the same glass that had been given her before, placing its axis, however, at 165°. After a few days of adaptation, she became comfortable and has remained so ever since, a period of almost two years. The error made by the former surgeon can be accounted for in no other way than that the superior oblique (it was her left eye) had rotated the eye through an arc of 15°, so as to bring its best meridian to the horizontal. Without a knowledge of this rotation, he hastily completed his work. The demand for rotation still existed after the glass had been given her, and was even more urgent than before, for now the rotation would bring perfect vision. Her symptoms continued, for the cause was not removed. A knowledge —at that time vague—of this tendency to rotate made me exceedingly careful in placing the axis of her cylinder. Vision being now perfect without rotation, the habit was soon broken and ever since she has been comfortable. I might refer to other cases, but such reference would occupy too much time.

The correction of astigmatism would be as easy as its detection were it not for this tendency to rotate. As it is, there is nothing more difficult in ophthalmic practice than the correction of astigmatism when the best meridian happens, as is frequently the case, to be out of the vertical or the horizontal. In some cases this tendency to rotate is so persistent that hours of patient work may be necessary for determining the best direction for the location of the axis of the cylinder. The strength of the needed cylinder is nothing like so difficult to determine. The rotation is not likely to be so persistent when the eye is under the influence of homatropia and when the other eye is covered, as when no medicine has been used and both eyes are allowed to look. If the best meridian is at 90° or 180° there can be no difficulty in placing the axis of the cylinder, for the patient's answers will always be the same, the habit of revolving never having been formed.

If after most careful work the patient can at no time decide between the two points of 100° and 105°, the point chosen must be at 100°, for it is nearest the perpendicular, the direction in which the eye has always rotated. If it happens to be wrong, it will result in partial relief; for the globe will not have to revolve so far as before in order to the best vision, and the rotation is in the same old direction. But if the best meridian is at 100°, and the axis of the cylinder is placed at 105°, the condition after is worse than the condition before the glass was given, for the direction of the rotation must be changed, though the arc to be described is less. What is true when the best meridian is near the vertical is also true when it is near the horizontal.

The arc between the best meridian and the vertical or horizontal, as the case may be, is often too great to be described by the rotation of the eye resulting from the contraction of one of its oblique muscles. In this case an inclination of the head will aid vision. We will suppose that the best meridian of the right eye is at 45°. I do not believe that the inferior oblique muscle could rotate the eye through so great an arc; but aided by leaning the head to the right the best meridian can be readily brought to the vertical. The head may incline 25°, leaving an arc of only 20° through which the eyeball must rotate in order to complete the 45°. This leaning of the head as well as rotation of the eyeball are alike involuntary, each being under the control of the guiding sensation in the retina.

The inclining of the head by astigmatics I do not claim as an original observation; but the observation of the function of the oblique muscles in certain forms of astigmatism I do claim for myself. I believe the observation both correct and practical.